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## COMPARATIVE FUEL ECONOMY WITH GASOLINE AND WITH ALCOHOL-GASOLINE BLENDS

One of the outstanding points of interest in connection with the use of alcohol-gasoline blends in automobile engines is the comparative fuel economy with gasoline and with the blend. Recently, the Bureau of Standards has undertaken two series of tests along this line.

In the first series of tests, runs were made with 15 cars, mainly of 1932 and 1933 models. All of them were in typical operating condition and were not reconditioned for the tests except that in some cases changes were made in the carburetor equipment to make possible adjustment of the mixture ratios in the course of the tests. The cars and the fuels were both selected with a view to being typically representative of products now in use on the highway. Tests were run over a course of about 89 miles, with the usual precautions to assure accurate measurements of distance, car speed, fuel consumption, and such other quantities as were necessary to secure ac-

curate results. The cars were driven, in all cases, by experienced drivers who were not informed as to the fuel in use on any particular test, thus avoiding any possible prejudice in this regard.

Since cars are operated on the road using a variety of carburetor adjustments or corresponding mixture ratios, these conditions were reproduced as follows: The fuels were classed in pairs, one of each pair being a straight gasoline and the other the same gasoline with 10 percent of absolute alcohol. Several carburetor adjustments were made on each of the cars and either one or both pairs of fuels were run in each car with each of the carburetor adjustments. Thus there was obtained a total of 43 direct comparisons between gasoline and the corresponding alcohol-gasoline blend, each run at the same setting of the carburetor in a given car. In making these tests, the cars were run as close to the legal speed limits throughout the course as traffic and traffic lights permitted. The driving time to cover the course of 89.2 miles was in most

cases very close to 2 hours and 50 minutes.

Four of the 15 cars showed on the average more than 1 percent poorer fuel economy with the gasoline than with the alcohol-gasoline blends and 6 cars showed at least 1 percent poorer fuel economy with the alcohol-gasoline blends. From the results on all cars, it was found that the average fuel economy with the 2 gasolines was 15.91 miles per gallon and with the 2 blends containing 10 percent of absolute alcohol it was 15.85 miles per gallon.

On the average, it was observed that somewhat poorer acceleration was obtained with the alcohol blend than with the gasoline. In order to obtain further information on this point, runs were made with 2 cars using carburetor adjustments for equal acceleration. Under these conditions, the average fuel economy in these two cars was 18.65 miles per gallon with the gasoline and 18.00 miles per gallon with the alcohol blend.

A second series of tests was conducted in cooperation with the American Automobile Association using 4 cars run at constant speed over a 10-mile course. Several different carburetor settings were employed with each car and runs with each carburetor setting were made using gasoline and a blend of this gasoline with 10 percent of absolute alcohol. The atmospheric temperature was much higher than during the first series of tests, so that the runs were conducted under conditions approaching vapor lock such as are encountered frequently during hot weather operation. The average fuel economy with the gasoline was 16.54 miles per gallon while with the alcohol blend, it was 16.02 miles per gallon. Greater differences in fuel economy were obtained with individual cars during the first series but the higher atmospheric temperature during these runs may have influenced the results, owing to the fact that an alcohol-gasoline blend boils more readily in the fuel lines than does the gasoline with which the alcohol is blended.

The foregoing results lead to the following conclusions:

(1) When a 10 percent blend of absolute alcohol with gasoline is substituted for the same gasoline without alcohol, without any change in carburetor adjustment, there is, on the average, no significant change in the miles per gallon under normal operating conditions and in the absence of vaporization in the fuel lines. If

vaporization is occurring, as often is the case in hot weather, the fuel consumption will tend to increase more rapidly with the alcohol blend than with the gasoline.

(2) The substitution of the 10 percent alcohol blend, under the above conditions, on the average, results in a small loss in acceleration or get-away.

(3) In order to restore the acceleration to that obtained with gasoline, a different carburetor adjustment must be made for the alcohol blend, and when this adjustment is made the alcohol blend gives, on the average, 4 percent less miles per gallon than the gasoline. It is found by experience that carburetors on the average are adjusted to give maximum acceleration.

Many models of automobiles are furnished with a fixed or unchangeable carburetor adjustment which is designed for maximum acceleration. If the character of fuel changes it is to be expected that a new fixed adjustment will be chosen such as still to secure the maximum acceleration, with an accompanying loss in fuel mileage for the blended fuel.

#### EFFECT OF OZONE ON ENGINE KNOCK

Ozone has been found to be more potent in causing detonation, or "fuel knock", than tetraethyl lead is in suppressing it. As little as two thousandths of a percent will cause an increase in detonation equal to that occasioned by substituting regular gasoline for premium gasoline. By using somewhat higher concentrations—up to one hundredth of a percent—regular and premium gasolines were made to knock as badly as does kerosene. These concentrations of ozone, however, had no effect on power or efficiency when the compression of the engine was such that no detonation occurred.

While the average motorist is more interested in suppressing detonation than in obtaining it, and while stratosphere flights are still too far in the future to cause concern over the possible effect of ozone in that region on the engines used, this discovery gives automotive and petroleum technologists a new tool with which to study detonation and to test theories thereof. As ozone and tetraethyl lead have opposite effects of the same order of magnitude, a study of the action of ozone may throw light on the mechanism whereby tetraethyl lead suppresses detonation.

**EXTREME-PRESSURE LUBRICANTS**

About 2 years ago, the Society of Automotive Engineers requested the Bureau to undertake an investigation of extreme-pressure lubricants, in co-operation with the automotive and petroleum industries, gear and bearing manufacturers, and various operators' organizations, with the object of developing satisfactory test methods which would be significant as regards service performance. A progress report on this work was presented at the meeting of the Society of Automotive Engineers, August 28 to September 4, and a description was given of a new lubricant tester developed at the Bureau.

The problems connected with extreme-pressure lubricants are of comparatively recent origin. In order to make possible further lowering of automobile bodies, many companies introduced a new type of gear in the differential housing. This new type of gearing, called hypoid gears, could not be satisfactorily lubricated with mineral oils, and it became necessary to develop special lubricants capable of standing up under the higher pressures involved. Since the development of extreme-pressure lubricants opened up a new field in lubrication, test methods for these lubricants were almost entirely lacking. Many test methods are required but the most important one is for the load-carrying capacity, since if the lubricant will not stand a high pressure, it does not make any difference how many other desirable properties it has. The Bureau's work to date has been confined to an investigation of load-carrying capacity, but will be extended to include other properties of extreme-pressure lubricants as soon as possible.

After considerable experimentation on methods for measuring load-carrying capacity, a machine was developed at the Bureau which appears to be satisfactory. Its basic principle is the use of two rotating steel rolls, essentially toothless gears, which rub against each other and which are lubricated by the extreme-pressure lubricant. The pressure between the two rolls is gradually increased until scoring of the metal surfaces occurs. The weight required to produce this pressure through suitable levers is called the load-carrying capacity of the lubricant. New rolls must be used for each lubricant and for each of the speeds, lubricant temperatures, and rates of loading at which it is tested. Lubri-

cants were tested which had a load-carrying capacity 20 times as great as mineral oils.

Tests were made on a number of lubricants which had been run in cars on the road by various companies, and the new tester was found to rate the lubricants in the same order as their service performance. These results appear so promising that a recommendation has been made that a number of these machines be constructed and that cooperative tests be conducted with them by several laboratories as a basis for standardization of the machine.

**FIRE HAZARD OF DOMESTIC HEATING INSTALLATIONS**

An annual fire loss for the country as a whole of about \$20,000,000 is reported as caused by stoves, furnaces, boilers, and their pipes; or between 9 and 10 percent of the loss from all known causes. If domestic heating installations are responsible for the same proportion of fires, the causes of which could not be ascertained, the total fire loss per year from such installations would be about \$45,000,000, equivalent to the destruction of the homes of some 50,000 people.

Fires may result from placing stoves, furnaces, and other heating equipment too near combustible walls, partitions, and ceilings, or from absence of adequate protection for floors. Definite information on the required spacings of heating equipment from unprotected combustible construction and on the protections needed for closer spacings has been lacking, the requirements in building codes being based on fragmentary information obtained from actual fires.

In tests recently completed at the Bureau, the results of which will appear as Research Paper No. 596 in the September number of the Bureau of Standards Journal of Research, stoves, furnaces, and their pipes were spaced at different distances from unprotected partitions, ceilings, and floors, and hot fires maintained for periods ranging from 1 to 7 hours. Protections of sheet metal, asbestos, or brick were then applied and the least resistance determined that would be safe from the standpoint of hazardous temperatures that might cause ignition of the wood. It was found that stoves for house heating should be spaced not less than 24 inches from walls faced with wood, and the smokepipes not less than 12 inches below wood joists or ceilings. If bright sheet metal

is applied to the walls, the spacing can be decreased to 12 inches. Similarly, plastered wood stud partitions, while requiring a spacing of not less than 18 inches when unprotected, will be safe if only 9 inches from stoves where the area exposed is covered with bright metal. Bright metal, such as galvanized iron, was found considerably more effective than black iron, since it reflects more of the radiant heat.

Tests with smokepipe thimbles indicated that a ventilated air space of not less than 4 inches all around the pipe, or of 2 inches if filled with insulation, is necessary where smokepipes pass through combustible partitions.

If stoves are without ashpits, or if ashpits are heated to near redness, an air space of 5 inches or more should be provided between the stove and a wood floor and the latter covered with incombustible insulation one fourth inch thick under sheet metal. If the fire box rests directly on the floor, the latter should be of incombustible materials throughout for the area surrounding the stove. For this condition, temperatures high enough to cause ignition of wood were transmitted through a 4-inch brick base. This explains the frequent occurrence of fires caused by ignition of wood forms left in place under brick or concrete arches supporting fireplaces.

Furnaces for hot-water installations and their pipes were found to present little hazard to adjacent construction as fired with either coal, oil, or gas. The hazard from warm-air heating ducts was found to be moderate, protections being required only where they enter floors or partitions relatively close to the furnace. In the case of the "pipeless" furnace, the down-draft of cold air around the warm-air duct protects the adjacent construction, the hazard with this equipment resulting mainly from placing combustible materials on the warm-air register or locating the latter beneath or too close to partitions.

Tests with a gas range having an oven without insulation indicated that 6-inch separation between the side of the oven and a wood partition gives reasonably safe conditions.

#### FIRE TESTS OF GYPSUM LATH PARTITIONS

In Technical News Bulletin No. 190, February 1933, an item was published relative to fire tests of wood-stud partitions faced with plaster on gypsum lath, made as a part of the series of fire tests of wood-framed and metal-

framed partitions and walls. There were included in the tests two with wood studs having facings of gypsum plaster on perforated gypsum lath that developed greater fire resistance than those faced with plaster on plain lath, because of better key for the plaster. With reference to this material the following statement was made:

Although perforated plaster board had been used experimentally as early as 1915 (Bureau of Standards Technologic Paper No. 70) it had not become commercially available until within the past year.

It has since been disclosed that this type of plaster base had been the subject of development for some time prior to 1915, when it was applied at this Bureau as one of a number of experimental bases for stucco and plaster subjected to weather-exposure tests, Patent Office records showing a plaster base of this type in an application filed in 1901. Also one manufacturer has informed us that perforated plaster board has been made by him for a period prior to 1915 up to the present time.

The fire tests concerned were made with partitions, and the application of the results is necessarily limited to this type of construction. Information on performance where the plaster base is applied horizontally, such as in floors, must be obtained from representative fire tests with such constructions.

#### DAMPNESS IN MASONRY WALLS ABOVE GRADE

Many inquiries regarding causes and methods of preventing dampness on the interior surface of exterior walls of brick, structural clay tile, concrete blocks, stone, and stucco are received by this Bureau. These inquiries come with greatest frequency during periods immediately following unusually severe rains. Those received recently indicate that the storm during the latter part of August, which was most intense along the Atlantic Coast, caused many damp walls. In order to answer such inquiries more fully than would be feasible by individual letters, a letter circular is being prepared, single copies of which will be obtainable upon request addressed to the Bureau of Standards.

Although nearly all building walls are permeable in the sense that they would leak if subjected to water under pressure, most walls of any type are satisfactory in service. Descriptions and observations of structures where dampness has occurred indicate that

faulty design and construction usually is the cause. Apparently the possibility of damp walls is not always considered during construction. These masonry materials sometimes are used as if they were impermeable and non-absorbent, whereas most of each type are readily permeable and all will absorb water.

It is evident, therefore, that in order to avoid dampness in masonry, provisions should be made to prevent the relatively large volumes of water which are collected on roofs or other horizontal surfaces from flowing onto the masonry. Horizontal surfaces of masonry, unless continuous and nearly impervious, either should be waterproofed or separated from the masonry below by flashing of durable materials. Also, constructions which project beyond exposed faces of walls should be provided with undercut drips, in order to shed the water away from the walls. As wind-blown rain may enter in relatively large quantities through cracks or other openings in the exposed vertical faces, exposed joints between the masonry and other materials and in the masonry, unless well sealed, offer an easy path for water.

Moisture from the ground or from rain splash may rise in the masonry by capillarity. This may be prevented by placing a layer of impervious materials, such as slate or sheet copper, in a horizontal joint 5 to 10 inches above the surface of the ground. This provision costs but little during construction.

Most builders agree that adequate flashing, the sealing of exposed joints, and the insertion of dampproofing are essential for maintaining freedom from dampness. Also furring generally is conceded to be desirable, but this is often omitted on account of its cost in spite of the fact that in regions subject to storms of considerable duration dampness is apt to occur occasionally on masonry walls 8 or 9 inches in thickness if the plaster is applied directly to the masonry. The amount of water which may strike an exposed vertical surface during severe rainstorms greatly exceeds the water-holding capacity of ordinary masonry walls 8 inches thick. Moreover, in storms lasting 1 to 4 days, there is ample time for the water to pass through such walls in sufficient quantities to cause dampness in the plaster. Examples of unfurred 8-inch walls which have given satisfactory service are numerous, but it is believed that many

of these are protected by surrounding objects such as buildings and trees.

The application of a so-called colorless waterproofing to the exposed faces of walls is often resorted to in attempts to check dampness. This is not always successful. In some cases lack of success may be attributed to failure to make needed repairs to flashings, inadequately waterproofed horizontal surfaces, and unfilled cracks. As none of the liquid waterproofings will seal openings that are large enough to be visible, these should be sealed before applying the solution. Moreover, the partial sealing of vertical surfaces by means of coatings when water may enter behind those surfaces may increase dampness on interiors, accelerate disintegration, and increase efflorescence.

Firms which specialize in the waterproofing of masonry walls generally prefer to follow the methods and to use the materials which they have found to be satisfactory. For home owners who desire to make their own repairs, probably the most satisfactory liquid waterproofing is a solution of paraffin wax, about 12 ounces of the wax to a gallon of gasoline. The melting point of the wax should be above that of summer wall temperatures (135° F. or higher). For satisfactory results the solution should be applied only when the masonry is dry and warm.

#### CARE OF FLOORS

In order to answer the numerous requests from the public for information on caring for floors, the Bureau has prepared Letter Circular No. 388 entitled "The Care of Floors." The following types of floorings are considered: Wood, cement (concrete), vitreous tile or ceramic, terrazzo, marble and travertine, linoleum, rubber, cork, asphalt tile and mastic, plastic magnesite cement, and slate. Suggested formulas for floor waxes or polishes and cleaning solutions are included, together with references to various publications and Federal Specifications. Interested parties can obtain a copy of this letter circular without charge from the Bureau of Standards, Washington, D.C.

#### SOME PROPERTIES OF ENGLISH CHINA CLAYS

Results of chemical and petrographic analyses show all of the clays to be similar, the kaolinite varying from 79 to 87 percent, muscovite from 8 to 14



percent, and free silica from zero to 3 percent. The P.C.E. values show no significant differences, averaging 34. This lack of difference is true also for the specific gravities of the dry clays which average 2.632 (true) and 1.45 (bulk), for the changes produced by heating, and for the linear thermal expansions of the heated specimens.

There is a marked difference between the extremes of values for moduli of rupture of the dry clays (max. 140 and min. 30 lb./in.<sup>2</sup>) as well as for dry specimens of equal parts clay and flint (max. 130 and min. 20 lb./in.<sup>2</sup>). Both the colloid content and the base exchange capacity vary considerably and there appears to be a relation between the latter property and the dry strength. Further, the clays which are weakest or strongest in the dry state tend to maintain the same relative positions after the various heat treatments.

The differences in values for dry strength and base exchange capacity, and the general relation between these values, seems to indicate a means of evaluating and differentiating clays of the china clay type and, furthermore, are the only means indicated as a result of this study. It is hoped to extend the study of these features in future work, especially as applied to a study of domestic china clays and kaolins now in progress.

The complete report appeared in the June 1933 issue of the *Journal of the American Ceramic Society*.

#### EFFECT OF PARTICLE SIZE OF A POTTER'S "FLINT" AND A FELDSPAR IN WHITE WARE

A feldspar and a potter's flint (crushed quartz) of commercial grade were separated by means of an air elutriator into four fractions. Each fraction contained particles grading from the finest originally present to maximum diameters of 10, 20, 35, and 75 microns, respectively. In addition, fractions containing particles varying from 35 to 75 microns were separated, and a portion of the original feldspar was reground to produce a material composed of particles 35 microns maximum diameter. The specific surface in cm<sup>2</sup>/g for each fraction was calculated from data obtained by microscopic count.

Various combinations of the several fractions of flint and of feldspar were incorporated in white-ware bodies. Specimens of these bodies were heated at 1,150°, 1,200°, 1,250°, 1,300°, and 1,350° C., and tested for linear shrink-

age, apparent porosity, strength in bending, and linear thermal expansion. Shrinkage and porosity results were compared with the specific surface values of the flint and feldspar in the respective bodies. Relative fusion and solution in the body was estimated by microscopic examination.

The data obtained indicate the possibility of vitrifying commercial ceramic white-ware with more finely ground materials, and without the use of auxiliary fluxes, at temperatures significantly lower than are now required in the industry.

For a more complete account of this investigation Research Paper No. 594 in the September number of the *Bureau of Standards Journal of Research* should be consulted.

#### THERMAL EXPANSION OF COLUMBIUM

An error occurs in this item on page 85 of *Technical News Bulletin* No. 196, August 1933. The equation and the sentence immediately following it in paragraph 3 of this article should read.

$$L_t = L_0 [1 + (7.06t + 0.00144t^2) 10^{-6}]$$

In this equation  $L_0$  represents the length of a specimen of columbium at 0° C. and  $L_t$  the length of any temperature  $t$  between -135° and +135° C.

#### THE SECOND SPECTRUM OF KRYPTON

The second spectrum of krypton (Kr II) characteristics of once ionized krypton atoms (Kr<sup>+</sup>) has been selected from various krypton spectra excited in Geissler tubes by noting intensity changes accompanying variations of capacity and inductance in the electrical circuit. A description and analysis of the Kr II spectrum which will be published as Research Paper No. 599 in the September number of the *Bureau of Standards Journal of Research*, includes estimates of relative intensities and wave length measurements for 1,050 lines extending from 2,080.53 Å in the ultraviolet to 10,659.5 Å in the infrared. Most of these lines (71 percent) have been classified as combinations of 128 energy levels, 112 of which have been more or less definitely identified with quantum numbers and electron configurations. Zeeman effects are quoted for 102 lines. In addition, 51 lines in the extreme ultraviolet (575.92-964.93 Å) are classified as transitions from excited states to the normal ones. An absolute value of 198,182 cm<sup>-1</sup> is derived for the ground level which fixes the ionization potential of Kr atoms at approximately 24.4 volts.

THE ANGSTROM<sup>1</sup>

In view of the present unanimous agreement and general practice in expressing optical wave lengths in terms of the so-called "international angstrom" the Bureau of Standards considers the time opportune to represent the international angstrom by the symbol "A."

Where the Rowland scale of wave lengths is intended it should be clearly specified as such.

The "angstrom" as at present used was defined and adopted in 1907 by the International Union for Cooperation in Solar Research (now the International Astronomical Union) and also adopted in 1928 by the International Conference on Weights and Measures.

The angstrom is equal to  $\frac{1}{6438.4696}$  of the wave length of cadmium red radiation, and within the limits of the most refined measurements of Michelson, and of Fabry, Perot, and Benoit, this value of the angstrom is identical with the definition 1 angstrom =  $10^{-10}$  meter.

## COMPARISON OF PHOTOGRAPHIC DEVELOPERS AND THE SPECIFICATION OF RELATIVE SENSITIVITY

From the standpoint of international standardization, the chief purpose of photographic sensitometry is to make possible a universally recognized system for expressing the properties of photographic materials. While several modes of expression have been proposed from time to time, a system, in order to be both flexible and complete, should be based on the density versus log-exposure graph devised by Hurter and Driffield.

It is the shape and position of this "H & D", or "characteristic", curve which determines the values of the quantities used to represent various properties of the emulsion, such as contrast, sensitivity, etc. The choice of an international standard developer is obviously important, since it influences the values of these quantities.

In Research Paper No. 598 in the September number of the Bureau of Standards Journal of Research, an endeavor has been made to bring out

the relative merits of several developers, particularly their effect on the shape of the characteristic curve. The results show that, compared with most metol-hydroquinone combinations, *p*-aminophenol and metol increase the length of the "toe" or the curve, with decreasing speed numbers. Incidentally, it was found that the standard developer solution is supersaturated with respect to the developing agent.

Changes in the sensitivity of the emulsions were measured by two indexes  $1/E_m$  and  $1/i$ .  $E_m$  is the exposure value of the point on the characteristic curve of the emulsion where the gradient is a certain value (in this work, 0.2). The inertia,  $i$ , is the exposure value of the point where the extended straight-line portion of the characteristic curve intersects a horizontal line representing the minimum density obtainable.

It was observed that, in general, the ratio of values of the two indexes, varied considerably with development time. In many cases and particularly with those developers which accentuate the "toe" of the characteristic curve, values of  $1/i$  may be decreasing while values of  $1/E_m$  are increasing with the time of development. In order to consider these apparently contradictory changes, it was necessary to set up a definition of relative sensitivity. From this definition it follows that comparisons of sensitivity may be made only when the emulsions have each received equivalent development, i.e., have been developed to equal values of  $\gamma$  when using the index  $1/i$ , or developed to equal mean gradients when using the index  $1/E_m$ . Whether or not the emulsions have definite straight-line sections will determine which index should be used.

Data were obtained confirming the conclusion of Luther that the gradient of the characteristic curve directly above the inertia is, in general, about one half gamma. In making sensitivity comparisons at a standard value of  $\gamma$ , one half this value might be taken as an "inertia gradient", the corresponding index of sensitivity being  $1/E_i$ . Thus, the sensitivity values obtained by  $1/i$  and  $1/E_i$  at the standard value of  $\gamma$  would be, in general, closely alike.

Experiments with varying quantities of potassium bromide showed that with most emulsions, if the development is sufficiently prolonged, sensitivity values will result which are greater than those obtainable with the same developer without bromide. Ad-

<sup>1</sup>To be published in the October 1933 issue of the Bureau of Standards Journal of Research, article by Dr. C. C. Kiehl, "Some Wave Lengths in the Spectrum of Silicon", and approved as general Bureau practice by Lyman J. Briggs, Director of the Bureau of Standards, Aug. 23, 1933.

vantage should be taken of this fact wherever high sensitivity and high contrast are both desirable, such as in some branches of spectrography and oscillography.

#### LACQUER-COATED RESISTORS OF HIGH RESISTANCE

Reliable resistors of high resistance of the order of  $10^3$  to  $10^6$  ohms have usually been found difficult to prepare. In a paper which has been submitted for publication in the *Review of Scientific Instruments* a method of preparation is described which has proved very successful. It consists essentially in coating a pyrex rod with graphite and coating the rod thus prepared with glyptal lacquer. This coating does not alter the value of the resistance, so that the resistance may be adjusted to the value desired before applying the lacquer. The lacquer effectively seals the resistance material against moisture. Such resistors appear to maintain a constant resistance indefinitely.

#### COMPARISON OF HIGH VOLTAGE X-RAY TUBES

A comparison has been made at the Bureau of the X-ray output as a function of the applied voltage for 2 thin glass X-ray tubes, 5 thick glass tubes, and 1 metal-centered tube on several generators of different voltage wave form. Thin glass tubes show about 15 percent greater output than thick glass tubes on constant potential, while the metal-centered tube gave about 15 percent less output. At any given effective (rms) voltage, the outputs of all glass tubes or all generators were nearly the same, and equal to the output on a constant potential of the same value. Likewise, at a given effective voltage, the quality (full absorption curve) was the same for all tubes on all generators.

Outputs of all tubes at a given peak voltage varied over a range of 25 percent between tubes and between different generators. The metal-centered tube output varied widely between half and full wave rectification at equal peak voltages. The same tube, however, gave the same output at any given effective voltage supplied by any generator.

Research Paper No. 595, in the September number of the *Bureau of Standards Journal of Research* contains the complete results of this work.

#### COURSE AND QUADRANT IDENTIFICATION WITH THE RADIO RANGE-BEACON SYSTEM

Certain circumstances may arise, especially when near the radio beacon, when a pilot may pass from one course or quadrant to another without his knowledge of it. When once so lost he may wander many miles in an attempt to reorient himself, since the 4 courses are all practically identical, and 2 of the 4 quadrants between the courses give identical indications. A method has been developed which obviates this difficulty. It consists of transmitting a directive signal composed of 1 dot in a westerly direction, a similar signal 2 dots in an easterly direction, 3 dots north, and 4 dots south; depending upon which set of these signals is the loudest, a pilot may determine his general direction from the beacon. Methods have been devised for transmitting these signals with practically no interruption to the visual beacon signals and during the station identification interruption of the aural beacon.

The change from the figure-of-eight transmission for the courses to the unidirectional cardioid transmission may be accomplished either by changing the point of coupling into suitable phasing sections in the transmission line feeding the antenna, or by superimposing on a figure-of-eight radiation, through a suitable hybrid coil, two in-phase radiations  $90^\circ$  out of phase with the figure-of-eight radiations. Standard relays operated by a motor-driven dot-sending device serve to make these changes. In the latter method a simple reversing relay serves to reverse the direction of transmission of the cardioid signals from a given set of antennas.

These identification signals may be easily applied to existing radio range-beacon stations of either the aural or visual type with the TL antenna system, as the only additions necessary are phasing sections and relays in the transmission line circuit inside the beacon station.

In the case of the visual beacon system, the double-modulation course signals are interrupted only for the period of each quick dot of the identification signal. This interruption is so short that the reeds in the reed indicator do not have time to drop except to about two thirds their normal amplitude and as they are equally damped the course indications do not change during this instant of decreased amplitude. It requires about 10 sec-



onds to send a series of identification signals twice, and they need be sent only once every 3 minutes.

The above system of quadrant and course identification is fully described in Research Paper No. 593 which will be published in the September number of the Bureau of Standards Journal of Research.

#### A CONTINUOUS RECORDER OF RADIO FIELD INTENSITIES

In Research Paper No. 597, which will be published in the September number of the Bureau of Standards Journal of Research, a recorder is described which may be used to make continuous 24-hour records of the received field intensities from radio transmitting stations operating on any frequency from 540 to 20,000 kilocycles per second. Because of the large variations (fading) in received field intensities, it was found necessary to make the scale of the recorder accommodate either a large range (e.g., 1 to 300,000 microvolts) or a small range (e.g., 100 to 300 microvolts) of radio-frequency voltages. This was accomplished by means of a special bridge arrangement in which one arm was the plate resistance of one of the vacuum tubes in the radio receiver used to amplify the received radio-frequency voltages. In order to eliminate the effects on the recorder of supply-voltage variations, the resistance of another vacuum tube was inserted in a parallel arm of the bridge, this latter tube not being affected by changes in the radio-frequency voltage. Several typical records made by the recorder are given in the paper. These records illustrate the flexibility of the recording method used. They also show several important characteristics of radio-wave propagation. Steady daytime field intensities for nearby stations are shown as well as fading daytime field intensities for the more distant stations, indicating the absence or presence of a sky wave of a magnitude comparable to that of the ground wave. At night, on all the records shown, the rapidity of fading may be seen to increase, the average value of the field intensity also increasing in some cases by a factor of about 100.

#### INTERNATIONAL MEETINGS ON WEIGHTS AND MEASURES

The International Committee on Weights and Measures is to hold its regular biennial meeting in Paris beginning September 26; a General Conference on Weights and Measures,

which is held at intervals of 6 years, will be convened October 3. The Conference includes representatives of all the 32 countries which have joined in the Metric Convention, while the International Committee consists of 18 members elected individually. Dr. Arthur E. Kennelly of Harvard University has recently been elected as a member, succeeding the late Dr. S. W. Stratton. Dr. Kennelly and Theodore Marriner, Counselor of the American Embassy at Paris, will represent the United States at the General Conference.

Important subjects scheduled for discussion at these meetings include the use of light waves as standards of length, the confirmation of the international scale of absolute temperatures, the adoption of a revised system of electrical units to supersede the present international units, and the acceptance of a common fundamental standard for intensity of light.

#### SIMPLIFIED PRACTICE RECOMMENDATION COVERING WIRE DIAMETERS FOR MINERAL AGGREGATE PRODUCTION SCREENS

Simplified Practice Recommendation R147-33, covering wire diameters for mineral aggregate production screens, is now available in printed form. The recommendation, which was proposed and formulated by members of the industry, provides for the width of clear opening, and the diameter, in inches, of light, standard light, standard heavy and heavy wire used for screens in production of mineral aggregates. This simplification program will effect a reduction of approximately 75 percent in the number of wire diameters formerly used.

Copies of this recommendation may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., at 5 cents each.

#### SIMPLIFIED PRACTICE RECOMMENDATION COVERING PAINTS, VARNISHES, AND CONTAINERS

Simplified Practice Recommendation R144-32, covering paints, varnishes, and containers, is now available in printed form. The recommendation, which was proposed and formulated by members of the industry, is the outgrowth of the simplified practice Limitation of Variety Recommendation No. 1, Paints and Varnishes, in which a definite maximum number of colors of paints and sizes of containers were recommended. Such maxima were recognized as limitations against fur-

ther diversification, thus furnishing a basis from which the present simplified practice recommendation has been developed.

The new schedule recommends several further reductions in the number of sizes and varieties of containers used in packing various kinds of paints and varnishes.

The table which provided for a maximum number of shades or tints to be produced or stocked by any one concern, in the limitation of variety recommendation, remains unchanged, and is included as a part of the present simplified practice recommendation.

Copies of this recommendation may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., at 5 cents each.

**REVISED SIMPLIFIED PRACTICE RECOMMENDATION COVERING GLASS CONTAINERS FOR PRESERVES, JELLIES, AND APPLE BUTTER**

The revised Simplified Practice Recommendation, R91-32, covering glass containers for preserves, jellies, and apple butter, is now available in printed form, and copies can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., at 5 cents each.

This recommendation was originally formulated by the industry in 1928. It is expected that by the inclusion of the 48-ounce jar for preserves, in the new schedule, the recommendation will prove of more value to the industry.

The revised program limits the stock sizes, based on avoirdupois weight of the food content of glass containers, to 9; jellies, to 7; and apple butter, to 4.

**EDUCATIONAL COURSES AT THE BUREAU OF STANDARDS, 1933-34**

Plans are now being formulated for a number of graduate study courses in Physics, Mathematics, and Chemistry, to be given at the Bureau during the coming winter. Courses of this character have been given regularly for the past 25 years, and have been recognized by many of the leading universities in allowing credit for advanced degree. Although these courses are planned primarily for members of the Staff of the Bureau of Standards, they are open on the same terms to any person who can furnish the instructor evidence of satisfactory preliminary training.

The educational committee has adopted the following two cycles as constituting the fundamental part of a graduate training in Physics:

**Physics cycle:**

Theoretical mechanics  
Electricity and magnetism (due this year)  
Advanced optics

**Mathematics cycle:**

Theory of functions  
Differential equations (due this year)  
Fourier series

One course of each cycle is normally given each year. Following is the list of courses which will be given during the current year:

*Course A.*—Electrical theory, Dr. C. Snow. Sixty lectures given 2 hours per week throughout the year. Tentative time: Mondays and Wednesdays at 8 a.m. in the East Building Lecture Room. The first meeting of the class will be Monday, October 9. Prerequisites: Ordinary differential equations, vector analysis, and mechanics. The subjects discussed will be in this order, general vector fields, electrostatics, magnetostatics, stationary electric currents, Ampere's theory of magnetism, the Maxwell-Lorentz field equations for the stationary state, electric conduction and Ohm's law, induced electric fields and the summarizing of the theory in the Maxwell-Lorentz field-and-force equations for time-variable fields, with a formulation of the concepts of electromagnetic energy, momentum, and energy flow.

*Course B.*—Differential equations, Dr. W. Edwards Deming. Sixty lectures given 2 hours per week throughout the year. Tentative time: Tuesdays and Thursdays at 8 a.m. The first meeting of the class will be Tuesday, September 26, in Room 300, South Building. Prerequisite: Calculus.

The course will begin with a review of some of the necessary calculus. An attempt will be made to cover the integrable types of differential equations, especially those of the first and second order. Equations with several variables will be treated together with their applications to physics. Symbolic methods will be devised for special types, but emphasis will be laid on general methods having wide utility. A review of series will be given, followed by the method of Frobenius for the solution of the more difficult types of equations by series. Numerical approximations by series and by Picard's and Runge's methods will be discussed. Singular solutions and their

interpretations will be treated. The course will conclude with special types of equations encountered in modern physical problems.

**Course C.—Atomic and nuclear structure.** Dr. C. J. Humphreys. Sixty lectures given 2 hours per week throughout the year. Tentative time: Mondays and Wednesdays at 4:30 p.m. The first meeting of the class will be Monday, September 25, in Room 214, Chemistry Building. Discussion of the basic phenomena of radiation including spectral series and radioactivity. A brief introduction to quantum mechanics discussing the modifications of the Bohr-Sommerfeld theory required by the concepts of Heisenberg, Schrödinger, Dirac, and Fermi. Application of the methods of Pauli and Hund to the determination of the distribution of energy levels in the atom. Discussion of fine structure and multiplet separations using Goudsmit's vector model. Zeeman effect, Paschen-Back effect, and phenomena appearing in the transition between strong and weak magnetic fields. Relation of hyperfine structure to nuclear theory. Present conceptions of nuclear structure. References to standard treatises and current literature.

**Tuition.**—The fee for each 60-lecture course will be \$25. Fees for courses continuing through the year are payable in two installments, if desired.

Further information regarding the above courses may be obtained by addressing the Educational Committee, Bureau of Standards, Washington, D.C.

#### INDUSTRIAL STANDARDIZATION AND COMMERCIAL STANDARDS MONTHLY

In Technical News Bulletin No. 195 (July 1933) the announcement was made that because of the limited funds available for printing, the Commercial Standards Monthly had been discontinued with the June number. The Bureau of Standards now desires to announce that through the courtesy of the American Standards Association the publication is being continued in combination with "Industrial Standardization" under the joint title "Industrial Standardization and Commercial Standards Monthly."

Arrangements have been made with the Superintendent of Documents for the American Standards Association to take over the subscription list of the "Commercial Standards Monthly" and to send the combined magazine to all names on this list during the re-

maining period covered by their subscriptions. The subscription rate for the combined magazine is \$4 per year (foreign, \$5); single copies, 35 cents. Subscriptions should be sent to the American Standards Association, 29 West Thirty-ninth Street, New York, N.Y.

The Bureau is cooperating with the American Standards Association in the preparation of material for the magazine to the end that it may meet as completely as possible the needs of all those interested in commercial standardization.

#### NEW AND REVISED PUBLICATIONS ISSUED DURING AUGUST 1933

##### Journal of Research<sup>2</sup>

Bureau of Standards Journal of Research, vol. 11, no. 2, August 1933 (RP nos. 584 to 592, inclusive). Price 25 cents. Obtainable by subscription.

##### Research Papers<sup>2</sup>

(Reprints from May and June 1933 Bureau of Standards Journal of Research.)

RP552. Purification of hydrocarbons by crystallization of liquid methane. Isolation of 2-methylheptane from petroleum; R. T. Leslie. Price 5 cents.

RP559. The determination of stresses from strains on three intersecting gage lines and its application to actual tests; W. R. Osgood and R. G. Sturm. Price 5 cents.

RP565. Recombination radiation in the cesium positive column; F. L. Mohler. Price 5 cents.

RP569. The precipitations and titration of magnesium oxyquinolate in the presence of calcium oxalate, and its application in the analysis of portland cement and similar silicates; J. C. Redmond. Price 5 cents.

RP571. The effect of gasoline volatility on the miscibility with ethyl alcohol; O. C. Bridgeman and D. W. Querfeld. Price 5 cents.

##### Simplified Practice Recommendations<sup>2</sup>

R91-32. Glass containers for preserves, jellies, and apple butter. (Supersedes R91-29.) Price 5 cents.

<sup>2</sup> Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D.C. Subscription to Technical News Bulletin 50 cents per year; subscription to Journal of Research, \$2.50 per year (United States and its possessions; Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 70 cents and \$3.25, respectively.

- R144-32. Paints, varnishes, and containers. Price 5 cents.  
 R147-33. Wire diameters for mineral aggregate production screens. Price 5 cents.

#### Technical News Bulletin<sup>2</sup>

Technical News Bulletin no. 196, August 1933. Price 5 cents. Obtainable by subscription.

#### LETTER CIRCULARS<sup>3</sup>

LC388. The care of floors.<sup>4</sup>

#### OUTSIDE PUBLICATIONS<sup>4</sup>

- Simplification of radio range-beacon position and quadrant identification, Air Commerce Bulletin (Department of Commerce, Washington, D.C.), July 1933.  
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<sup>2</sup> See footnote on preceding page.

<sup>3</sup> It is the intent of the Bureau to distribute single copies of these mimeographed letter circulars on request only to those parties having a special interest in the individual letter circular. Economy necessitates limitation in the number of copies issued. It is not the intent to supply parties with a copy of each letter circular issued during the month. Letter circulars are necessarily of a temporary nature designed to answer numerous inquiries on a given subject. Requests should be addressed to the Bureau of Standards, Washington, D.C.

<sup>4</sup> "Outside publications" are not for distribution or sale by the Government. Requests should be sent direct to publishers.

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